

TABLE 1 OF § 1066.215—SUMMARY OF REQUIRED DYNAMOMETER CALIBRATIONS AND VERIFICATIONS—Continued

Type of calibration or verification	Minimum frequency <sup>a</sup>
§ 1066.265: Acceleration and deceleration	Upon initial installation and after major maintenance.
§ 1066.270: Unloaded coastdown .....	Upon initial installation, within 7 days before testing, and after major maintenance.

<sup>a</sup> Perform calibrations and verifications more frequently, according to measurement system manufacturer instructions and good engineering judgment.

(c) *Automated dynamometer verifications and calibrations.* In some cases, dynamometers are designed with internal diagnostic and control features to accomplish the verifications and calibrations specified in this subpart. You may use these automated functions instead of following the procedures we specify in this subpart to demonstrate compliance with applicable requirements, consistent with good engineering judgment.

(d) *Sequence of verifications and calibrations.* Upon initial installation and after major maintenance, perform the verifications and calibrations in the same sequence as noted in Table 1 of this section. At other times, you may need to perform specific verifications or calibration in a certain sequence, as noted in this subpart.

(e) *Corrections.* Unless the regulation directs otherwise, if the dynamometer fails to meet any specified calibration or verification, make any necessary adjustments or repairs such that the dynamometer meets the specification before running a test. Repairs required to meet specifications are generally considered major maintenance under this part.

#### § 1066.220 Linearity verification.

(a) *Scope and frequency.* Perform linearity verifications upon initial installation, within 370 days before testing, and after major maintenance. Note that these linearity verifications may replace requirements previously referred to as calibrations. The intent of linearity verification is to determine that a measurement system responds accurately and proportionally over the measurement range of interest. Linearity verification generally consists of introducing a series of at least 10 reference values (or the manufacturer's recommend number of reference values) to a measurement system. The

measurement system quantifies each reference value. The measured values are then collectively compared to the reference values by using a least-squares linear regression and the linearity criteria specified in Table 1 of this section.

(b) *Performance requirements.* If a measurement system does not meet the applicable linearity criteria in Table 1 of this section, correct the deficiency by re-calibrating, servicing, or replacing components as needed. Repeat the linearity verification after correcting the deficiency to ensure that the measurement system meets the linearity criteria. Before you may use a measurement system that does not meet linearity criteria, you must demonstrate to us that the deficiency does not adversely affect your ability to demonstrate compliance with the applicable standards.

(c) *Procedure.* Use the following linearity verification protocol, or use good engineering judgment to develop a different protocol that satisfies the intent of this section, as described in paragraph (a) of this section:

(1) In this paragraph (c), the letter “y” denotes a generic measured quantity, the superscript over-bar denotes an arithmetic mean (such as  $\bar{y}$ ), and the subscript “<sub>ref</sub>” denotes the known or reference quantity being measured.

(2) Operate a dynamometer system at the specified temperatures and pressures. This may include any specified adjustment or periodic calibration of the dynamometer system.

(3) Set dynamometer speed and torque to zero and apply the dynamometer brake to ensure a zero-speed condition.

(4) Span the dynamometer speed or torque signal.

(5) After spanning, check for zero speed and torque. Use good engineering

judgment to determine whether or not to rezero or re-span before continuing.

(6) For both speed and torque, use the dynamometer manufacturer's recommendations and good engineering judgment to select reference values,  $y_{\text{refi}}$ , that cover a range of values that you expect would prevent extrapolation beyond these values during emission testing. We recommend selecting zero speed and zero torque as reference values for the linearity verification.

(7) Use the dynamometer manufacturer's recommendations and good engineering judgment to select the order in which you will introduce the series of reference values. For example, you may select the reference values randomly to avoid correlation with previous measurements or the influence of hysteresis; you may select reference values in ascending or descending order to avoid long settling times of reference signals; or you may select values to ascend and then descend to incorporate the effects of any instrument hysteresis into the linearity verification.

(8) Set the dynamometer to operate at a reference condition.

(9) Allow time for the dynamometer to stabilize while it measures the reference values.

(10) At a recording frequency of at least 1 Hz, measure speed and torque values for 30 seconds and record the arithmetic mean of the recorded values,  $\bar{y}_i$ . Refer to 40 CFR 1065.602 for an example of calculating an arithmetic mean.

(11) Repeat the steps in paragraphs (c)(8) through (10) of this section until you measure speeds and torques at each of the reference conditions.

(12) Use the arithmetic means,  $\bar{y}_i$ , and reference values,  $y_{\text{refi}}$ , to calculate least-squares linear regression parameters and statistical values to compare to the minimum performance criteria specified in Table 1 of this section. Use the calculations described in 40 CFR 1065.602. Using good engineering judgment, you may weight the results of individual data pairs (*i.e.*,  $(y_{\text{refi}}, \bar{y}_i)$ ), in the linear regression calculations.

TABLE 1 OF § 1066.220—DYNAMOMETER MEASUREMENT SYSTEMS THAT REQUIRE LINEARITY VERIFICATIONS

Measurement system	Quantity	Linearity criteria	$a_1$	SEE	$r^2$
		$ x_{\text{min}}(a_1 - 1) + a_0 $			
Speed .....	$S$	$\leq 0.05\% \cdot S_{\text{max}}$ .....	0.98–1.02	$\leq 2\% \cdot S_{\text{max}}$ .....	$\geq 0.990$
Torque (load) .....	$T$	$\leq 1\% \cdot T_{\text{max}}$ .....	0.98–1.02	$\leq 2\% \cdot T_{\text{max}}$ .....	$\geq 0.990$

#### § 1066.225 Roll runout and diameter verification procedure.

(a) *Overview.* This section describes the verification procedure for roll runout and roll diameter. Roll runout is a measure of the variation in roll radius around the circumference of the roll.

(b) *Scope and frequency.* Perform these verifications upon initial installation and after major maintenance.

(c) *Roll runout procedure.* Verify roll runout as follows:

(1) Perform this verification with laboratory and dynamometer temperatures stable and at equilibrium. Release the roll brake and shut off power to the dynamometer. Remove any dirt, rubber, rust, and debris from the roll surface. Mark measurement locations on the roll surface using a permanent

marker. Mark the roll at a minimum of four equally spaced locations across the roll width; we recommend taking measurements every 150 mm across the roll. Secure the marker to the deck plate adjacent to the roll surface and slowly rotate the roll to mark a clear line around the roll circumference. Repeat this process for all measurement locations.

(2) Measure roll runout using a dial indicator with a probe that allows for measuring the position of the roll surface relative to the roll centerline as it turns through a complete revolution. The dial indicator must have a magnetic base assembly or other means of being securely mounted adjacent to the roll. The dial indicator must have sufficient range to measure roll runout at